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theory is to be regarded as firmly established on fact. However, it deserves investigation.—J. J. WOLFE.

THE MITOSES in the megaspore mother cell of several liliaceous forms, especially *Galtonia candicans*, *Scilla sibirica*, and *Tulipa Gesneriana*, are described in great detail in a paper by Schniewind-Thies.⁸ In *Galtonia* the mother cell usually gives rise to a row of four potential megaspores, but occasionally only two cells appear in the row, one of which may germinate directly to form the embryo sac, a transition between the condition in *Lilium*, where the megaspore mother cell develops directly into the embryo sac, and the condition where one of four megaspores produces the sac. In any case, the first mitosis in the megaspore mother cell shows the reduced number of chromosomes. The second division in a form like *Lilium* corresponds in all essential details with the second division in a form which is to have two or four megaspores, and there is a similar correspondence in the third divisions. In *Scilla* it is interesting to note that while the number of chromosomes in the gametophyte is eight, the number in the sporophyte varies from eight to sixteen. In *Tulipa*, at the first mitosis in the mother cell, each of the daughter nuclei contains twelve chromosomes, and in the two succeeding mitoses this number is maintained at the micropylar end of the sac; but at the chalazal end the sporophyte number may appear at the second division, or the number may vary, fifteen, sixteen, and twenty-one having been counted. The writer believes that the new generation begins with the reduction division, both in the embryo sac mother cell and in the pollen mother cell, and he has no doubt that the processes in the ovule and in the microsporangium of angiosperms are homologous. The four potential megaspores correspond to the four microspores (pollen grains); cases of two potential megaspores show a step toward the further reduction which is found in forms like *Lilium*. The fact that the megaspores take the form of a row is due to position, there being no opportunity for early isolation and rounding off as in microsporangia.—CHARLES J. CHAMBERLAIN.

NOTES FOR STUDENTS.

FRANCIS E. LLOYD⁹ has described vivipary in *Podocarpus Makoyi*. The embryo develops continuously, the hypocotyl passing out through the micropyle while the seed is still attached. The phenomenon is said to be well known in Japan, but does not seem to have been recorded in English.—J. M. C.

⁸ Die Reduction der Chromosomenzahl und die ihr folgenden Kerntheilungen in den Embryosackmutterzellen der Angiospermen. 8vo. pp. 34. pls. 5. Jena: Gustav Fischer. 1901.

⁹ *Rhodora* 2: 113-117. figs. 3. 1902.

F. PÉCHOUTRE¹⁰ has made an extended study of the development of the ovule and seed of the Rosaceae. He describes in detail the formation of the ovular protuberance and the integuments. He finds remarkable uniformity in the development of the sporogenous tissue, a large number of species, representing all regions of the family, showing the many-celled archesporium and general characters of the classic *Rosa livida*. The early stages in the development of the embryo were studied in numerous forms, special stress being laid upon the various phases of the suspensor. All gradations are shown from the small, more or less elongated filamentous form to the short and compact massive type.—J. M. C.

IN LIEFERUNG 213 of Engler and Prantl's *Natürlichen Pflanzenfamilien*, Potonié discusses the Cycadofilices. He notes that this alliance, originally set up in his *Pflanzenpalaeontologie* (1898), has been adopted by Dr. Scott in his *Studies in Fossil Botany*, and by Mr. Seward in the arrangement of the vegetable fossils in the British Museum. Anatomical characteristics make it very probable that the forms included under the heading Cycadofilices are intermediate between the ferns and gymnosperms, although practically nothing is yet known of their reproductive organs. The illustrations, where they are not original, are largely reproductions of the admirably clear figures in Dr. Scott's recent text-book of palaeobotany.—E. C. JEFFREY.

M. L. LUTZ¹¹ shows by cultures that certain algae and fungi are able to absorb and apparently to assimilate amides without first breaking them down into ammonium salts. His experiments were performed upon *Pleurococcus miniatus* and *Raphidium polymorphum* for algae, and upon *Pencillium glaucum* for fungi. A number of amides were tested. The results are in general in accord with those of Czapek¹² in the same field, a fact to which the author calls attention in a note. The only point of disagreement between the two series of cultures independently made by these two authors is in regard to the effect of butyramide upon *Aspergillus*. Czapek failed to obtain growth in this substance; while Lutz records an excellent development therein.—B. E. LIVINGSTON.

THE EFFECT of dissolved oxygen and carbon dioxid upon the development of plankton has been investigated by Whipple and Parker.¹³ The phys-

¹⁰ Contribution a l'étude du développement l'ovule et de la graine des Rosacées. Ann. Sci. Nat. Bot. VIII. 16: 1-158. figs. 166. 1902.

¹¹ Recherches sur la nutrition des Thallophytes a l'aide des amides. Bull. Soc Bot. France 48: 325-334. 1902.

¹² Zur Kenntniss der Stickstoffversorgung und Eiweissbildung bei *Aspergillus niger*. Ber. Deut. Bot. Gesells. 130-139. 1901. Also, Untersuchungen über die Stickstoffgeweinung und Eiweissbildung der Pflanzen. Hofmeister's Beiträge 1: 538-560. 1902.

¹³ WHIPPLE, G. C. and PARKER, H. N., On the amount of oxygen and carbonic acid dissolved in natural waters and the effect of these gases upon the occurrence of microscopic organisms. Trans. Amer. Micr. Soc. 23: 103-144. pls. 19-22. 1901.

ical principles underlying solution of these gases and the methods best adapted to their determination in natural waters are quite fully treated. Ordinarily both carbon dioxide and oxygen are necessary for the life of the micro-organisms in natural waters. Consideration of the relative amounts of these gases is shown to be of great value in explaining certain problems of vertical and seasonal distribution. What seems to be a causal relation is pointed out between the great carbon dioxide content of ground waters and their peculiar tendency to support diatom growth. Interesting curves and tables accompany the paper.—B. E. LIVINGSTON.

JOHN CUTLER TORREY,¹⁴ in studying the "Cytological changes accompanying the secretion of diastase," concludes that among the grasses "diastase of secretion" arises in the nucleus of the epidermal cells of the scutellum; that zymogenesis begins in the nuclei before the advent of the resting period; that at some time during the first and third days of germination the diastase-secreting cells swell to three or four times their original size; that during the first and third days there are "waves" of secretion, so that this process may be described as intermittent, but from that time on, until final exhaustion of the cells, the secretion is more continuous; that the secreting cells begin to degenerate about the tenth day; that it is highly probable that the chromatin takes an active part in the zymogenesis; that the nucleus is in this case very clearly the metabolic center of the cell; and that there is a marked difference in secretory processes in plants and animals,—J. M. C.

L. COCKAYNE¹⁵ continues the account of his studies of the seedlings of New Zealand and Chatham island plants. He finds that many species common to New Zealand and Chatham islands are similar in their young stages, but become different in their adult forms, the New Zealand forms becoming strongly xerophilous in structure, while those from Chatham island retain their juvenile characters. A number of New Zealand species pass through three distinct stages in their individual development: first the juvenile form, then this gives place to an extremely xerophilous form, and finally this is replaced by a form which resembles the first. Similar forms from Chatham island do not pass through the xerophilous stage, and the New Zealand plants when grown under favorable conditions of moisture omit this stage also, resembling the juvenile form throughout. The author considers the bearing of these facts on the relationships and history of the flora of these two regions.—W. B. MCCALLUM.

VALUABLE DETERMINATIONS of the constituents of the fruit of the coconut (*Cocos nucifera*) are given by J. E. Kirkwood and W. J. Gies.¹⁶ The milk

¹⁴Bull. Torr. Bot. Club 29: 421-435. 1902.

¹⁵An inquiry into the seedling forms of New Zealand phanerogams and their development. Trans. New Zealand Inst. 33: 265-299. *pls. 10-12*. 1900.

¹⁶Chemical studies of the coconut with some notes on the changes during germination. Contrib. N. Y. Bot. Garden no. 26. Bull. Torr. Bot. Club 20: 321-359. *pl. 19. figs. 1-6*. 1902.

of the green nut is an aqueous solution containing large proportions of a reducing sugar (probably a mixture of dextrose and galactose) and some cane sugar, together with much hydrochloric and phosphoric acid in combination with both alkaline and earthy bases. There is very little proteid in either milk or endosperm. In the mature nut the milk contains little monosaccharide and much cane sugar. The mature endosperm contains much fat and insoluble carbohydrate material. The fat is mainly glycerides of caprylic, lauric, myristic, and palmitic acids. Besides cellulose, a polysaccharide gum is present in considerable quantity, and several sugars, but these only in small amount. The proteid present is largely edestin. A diastatic enzyme and oxydase occur in both milk and endosperm, but no appreciable quantities of any protoelytic or adipolytic enzyme were found.—B. E. LIVINGSTON.

MISS ETHEL SARGANT¹⁷ has long been studying the vascular system in monocotyledonous seedlings, and has reached the conclusion that the symmetry and structure of the vascular system of the seedling can be used as a guide to the phylogeny of the Liliaceae. She regards the genus *Anemarrhena* as a primitive type in the family, two opposed collateral bundles occurring in the cotyledon. This is taken to represent the "bicotyledonary" system of a remote ancestor. In other words, the monocotyledons are specialized, reduced forms of dicotyledons, in which two separate cotyledons have gradually united. It will be recalled that Mr. H. L. Lyon¹⁸ has suggested on the other hand, that the dicotyledonous condition has been derived from the gradual splitting of the single cotyledon of monocotyledons. Miss Sargent calls attention to the fact that among monocotyledons the apex of the cotyledon often remains within the endosperm, a habit that "would naturally lead in course of time to the fusion of the cotyledons within the seed." In a later number of the same journal¹⁹ Mr. A. G. Tansley objects to this "reduction" theory.—J. M. C.

GEORGE JAMES PEIRCE²⁰ has studied "The root-tubercles of bur clover (*Medicago denticulata* Willd.) and of some other leguminous plants." His conclusions are that though the bacteria that form the tubercles are usually only slowly motile in artificial cultures, this proves nothing as to their motility in the soil: that the proportion of root hairs affected is very small; that infection of the roots may be resisted by cutting off the infected ends of the root hairs; that the bacteria enter a root hair by softening or dissolving a small portion of the wall and moving or growing through this; that the infection thread is chemotropically attracted to the layer of cells next the central cylinder; that the tubercles originate only endogenously and from the same

¹⁷ The origin of the seed-leaf in Monocotyledons. *New Phytol.* 1: 107-113. 1902.

¹⁸ *Minn. Bot. Studies* 643-655. 1901.

¹⁹ *New Phytol.* 1: 131-133. 1902.

²⁰ *Proc. Calif. Acad. Sci.* III. Bot. 2: 295-328. *pl.* 29. 1902.

layer that gives rise to lateral roots, and hence are morphologically lateral roots; that tubercles are largest and most numerous near the surface of the soil; that the presence of bacteria prevents the infected cells from forming starch grains; that the bacteria cause the degeneration and almost complete destruction of the nuclei; that infected cells soon lose the power of division, though not of growth; that the relation of the bacteria to their host-cells is parasitism; that it is difficult to understand how the plant as a whole can profit by an association which injures and finally destroys the cells.—J. M. C.

LUIGI BUSCALIONI,²¹ in an extensive preliminary notice, describes his studies on the development of the root in the monocotyledons. His results are new and interesting in many respects; and their early publication *in extenso* is to be desired. The author calls attention to the fact that in the root of the same species the periblem and plerome may originate from a common meristem, or have distinct and separate initials according as the root is of larger or smaller size. The medulla in the case of large roots often shows its community of origin with the cortex by the presence of raphide cells such as are characteristic only of the extrastelar fundamental tissues. The apparent medulla, which is often present in smaller roots, the author does not consider to be a true medulla, and designates it *medulliform tissue*. These results are of great interest from the standpoint of existing stelar hypotheses. The root would seem to be a specially favorable organ for the investigation of these problems, both on account of its primitive structure and the clear limitation of the primary meristems. Another novelty is the announcement that the origin of the tracheary elements of the root is centrifugal, in spite of the fact that the order of their lignification is centripetal. In the Dioscoreaceae and Asparagaceae, the mother cells of the tracheary elements are multinucleate.—E. C. JEFFREY.

L. GUIGNARD²² has added certain Solanaceae to the list of plants in which "double fertilization" has been observed. His work was chiefly with *Nicotiana Tabacum* and *Datura laevis*, although enough was seen of *N. rustica*, *D. stramonium*, and *D. Tatula* to indicate that they exhibit the same phenomenon. In *Nicotiana* the generative cell divides in the pollen grain, while in *Datura* it divides after entering the pollen tube, and in both cases the male cells are small and ovoid, or very slightly elongated. In *Datura* a remarkable change in the form of the tube nucleus was observed to occur in the tube, a very much elongated and irregular filamentous form being assumed. In both genera the tube enters a synergid and discharges, the two male cells rapidly approaching the egg nucleus and the polar nuclei. In *Nicotiana* the

²¹ Sull'anatomie de cilindo centrale nelle radice delle Monocotiledoni. *Malpighia* 15: 276-296. 1902.

²² La double fécondation chez les Solanées. *Jour. Botanique* 16: 145-167. *figs.* 45. 1902.

polar nuclei do not fuse until after fertilization, while in *Datura* the fusion is complete before fertilization. The usual position of the polar nuclei or the fusion nucleus during fertilization is in contact with the egg. The first division of the primary endosperm nucleus is followed by a transverse wall across the sac, dividing it into two approximately equal chambers. In *Datura* this is followed by other transverse walls, so that the sac consists of four superposed chambers. In both genera the subsequent divisions of the endosperm cells occur in various planes and are accompanied by wall formation.—J. M. C.

ITEMS OF TAXONOMIC INTEREST are as follows: GOTTFRIED LUZE (Verhandl. Zool.-Bot. Gesells. Wien 52: 304-305. 1902) has described a new genus (*Pseudocalea*) of Staphyleaceae from southeastern Europe.—LEROY ABRAMS (Torreya 2: 122. 1902) has described a new *Hemizonia* from California.—N. L. BRITTON (*idem* 123) has described a new *Hydrophyllum* from Minnesota.—HENRY EGGERT (*idem* 123) has described a new *Verbena* from Texas.—C. L. SHEAR (Bull. Torr. Bot. Club 29: 449-457. 1902) has described new species of *Secotium*, *Scleroderma*, *Cucurbitaria*, *Fusicladium*, *Illosporium*, *Phragmidium*, *Aecidium* (2), *Diatrypella*, *Pleomassaria*, *Camarosporium*, and *Haplosporella*, and has established the following new genera: *Cryptoporus* (formerly a section of *Polyporus*)₂ and *Plectrothrix* (nearest to *Monosporium*).—E. J. DURAND (*idem* 458-465) has described new species of *Discomycetes* in *Ciboria* (2) and *Sclerotinia*.—F. LAMSON-Scribner and E. D. MERRILL (*idem* 466-470) have described new species of *Argrostis*, *Elymus* (2), *Festuca*, *Sitanion*, and *Trisetum*.—ALICE EASTWOOD (*idem* 471-474. *pl.* 21) has described five new species of *Nemophila* from the Pacific coast.—SPENCER LEM. MOORE (Jour. Linn. Soc. Bot. 35: 305-367. *pl.* 8. 1902), in describing numerous new African Compositae, has published a new genus (*Artemisiopsis*) of Inuloideae.—P. HENNINGS (Hedwigia 41: 145-149. 1902), in completing his account of the Javanese fungi collected by Professor Zimmermann, has described a new genus (*Discomycopsella*) of Leptostromataceae.—J. M. C.

MISS BLANCHE GARDNER,²³ in studying cell division in root tips of *Vicia Faba*, concludes that the nucleolus plays an important part in heredity. The statement is made that "the nuclear thread dips into the nucleolus" at one or several points and continues so until the nucleolus transfers itself into the thread. After the nucleus has divided, nearly all the chromatin is passed back and forms the nucleolus again. The conclusion is reached that the nucleolus is not a nutritive center. "The nucleolus is, at least in large part, a mass of chromatin material packed together in rounded form during the resting stage, and during this stage it is the important chromatin center. During division it becomes transformed into chromosomes. The nuclear

²³Observations on growth and cell division in the root of *Vicia Faba*. Contrib. Bot. Lab. Univ. Penn. 2: 150-182. *pl.* 3. 1902.

thread formed in the earliest stages of division merely serves as a path along which the nucleolus passes its chromatin." The author has evidently overlooked or failed to take into consideration the chromatin-nucleoli or karyosomes, which in well stained preparations of *Vicia* are always visible in the resting nuclei. The fact that in some forms of mitosis the true nucleolus—or plasmosome—is at the time of division entirely cast out of the nucleus into the cytoplasm, where it degenerates, has not been taken into consideration. That the nucleolus does contribute something to the chromatin is probably true, but it is very doubtful if it plays such an important part as has been assigned it by the author. The conclusion seems to be based largely on the staining reactions of iron-haematoxylin and Bordeaux red. Most cytologists now place little reliance on staining reactions.—W. J. G. LAND.

A TURNIP ROT has been under study for some time by Professor M. C. Potter of the Durham College of Science, England, and a number of articles have been published concerning it. In a communication to the Royal Society on June 12 the parasitic activity of the disease organism, *Pseudomonas destructans*, is minutely described. By direct observation it was seen to swell the wall of a healthy cell to two and a half times its natural thickness within an hour, by action of cytase which it excretes. The swelling could be recognized almost at once upon the introduction of the germs. Almost an hour, however, was required to make evident the toxic action by which the protoplasm is killed, followed by contraction and separation from the wall. The penetration of the cell wall by the bacteria was also directly observed, the time required being about three hours. All stages of this operation were well demonstrated by fixing, paraffin imbedding, and sectioning. Differential staining, using ruthenium-red for the walls and Löwit's method for the bacteria and their flagella, brought out the fact with great clearness. The enzym secreted by the organism is incapable of acting upon the mature and old epidermis. Entrance into the plant under field conditions appears to be largely through wounds. Such an unequivocal demonstration of a bacterial disease of plants is a notable addition to our knowledge of plant pathology, and is especially interesting as it comes from across the Atlantic, where it has been, and is still, much the fashion among writers of all classes to deny that bacteria are capable of originating disease in plants.—J. C. ARTHUR.

IN A PAPER READ before the Society for Plant Morphology and Physiology, J. M. Macfarlane²⁴ gives an historical résumé of the progress of plant cytology. He classifies the problems of plant cytology as morphological, physiological, experimental, ecological, evolutionary, and taxonomic. He suggests that the nucleoplasm and general cytoplasm may be regarded

²⁴Current problems in plant cytology. Contrib. Bot. Lab. Univ. Penn. 2: 183-204. *pl.* 18. 1902.

as the vegetative substance of the cell, the chromatin granules as the highly specialized hereditary substance, and the linin as an intermediate substance which transmits hereditary peculiarities in a slow degree from the cytoplasm to the chromatin, and that the linin is in part the bearer of hereditary qualities. He considers that undue prominence has been given to the chromatin granules as the bearers of heredity. He thinks more light would be thrown on the tropisms if the cytological changes that originate or accompany them were accurately determined. He believes that the only correct guide to the evolutionary affinities of the plant groups and the development of species within these groups is to be found in the study of the morphological details of varieties and species based on the cell as the ultimate factor; also that it will not be possible to classify on a natural plan until exact information has been obtained and recorded in terms of cell life, of structural features, such as for example pigmentation of certain areas, the upbuilding of unicellular or multicellular hairs of definite structure, or the development of thickening zones, etc. When such data have been accumulated "it will be possible to classify plants on a natural plan, instead of, as now, by selecting one or two points of resemblance—not necessarily of morphological contact—as a taxonomic basis."—W. J. G. LAND.

IN A PRELIMINARY paper concerning a series of experiments now in progress at Harvard Botanic Garden, A. B. Plowman²⁵ gives some interesting results. Both soil and water cultures of seedlings subjected to as near normal conditions of temperature, light, and moisture as possible, were treated with both static and kinetic charges, through a range of potential from 0.5 to 500 volts. Seeds near the anode were killed by a current of 0.003 amperes or more, while those near the cathode were little affected or even stimulated. In both water and soil cultures of seedlings the same facts were established. In case the current was allowed to act for a sufficient length of time the ill effects were produced at all points between the electrodes, but slower in the soil cultures. With a current of 0.08 amperes or less the seedlings near the cathode showed an increase in the rate of growth. A provisional theory based on the disputed ionic theory is offered in explanation. From certain facts established by experiment the conclusion is made that negative charges stimulate and positive charges paralyze the protoplasm of young seedlings. For example, a positive charge of 500 volts killed lupine seedlings, while a negative charge of similar potential actually stimulated the plants; in water cultures subjected to a weak current of electricity the root-tips turn towards the anode. The explanation for the latter is that the side of the root toward the anode is retarded in its growth by the positive ions, while the opposite side is stimulated by the bombardment of the negative

²⁵ Certain relations of plant growth to the ionization of the soil. *Am. Jour. Sci*

ions. Since the plant body is electro-positive to the soil, the negative electrons are being discharged to the plant in its normal physiological activity and are beneficial, while the reverse condition is detrimental.—F. D. HEALD.

THE EXPERIMENTAL MORPHOLOGY of the potato tuber has been taken up again by Vöchting.²⁶ The French variety "Marjolin" was grown in pots in garden soil. In darkness at a temperature of 6–7° C. few roots, but numerous new shoots, are developed. The latter take the form of small tubers, and never bear the small leaves normally produced in darkness. At a temperature of 25–27° C (about the optimum for growth) both roots and shoots are produced in large numbers, and the latter all have the form of normal etiolated shoots. As the temperature is decreased below the optimum, more tubers and fewer leaf-bearing shoots are produced, and in the neighborhood of the minimum for growth all the shoots are tuberous. The temperature seems to be directly effective in this response. If new tubers have begun to form in the cold, and then the culture be transferred to the optimum temperature, tuber formation ceases and the development of leafy shoots begins, to continue while the temperature is suitable. A corresponding change from the formation of leafy shoots to that of tuberous ones follows a change of temperature in the opposite direction, but leafy shoots started in the cold continue to grow as such at low temperatures. However, they change their response to the gravity stimulus entirely; while at the higher temperature they are negatively geotropic, at the lower they become positively so. The influence of the amount of water in the soil is almost as important as that of temperature. At a temperature suitable for the production of leafy shoots a culture with little water produces only tubers. When water is added to the soil leafy shoots are developed. In cultures with dry air above the soil, the leaf-bearing shoots creep along the surface of the substratum. The author concludes they are positively hydrotropic. The partial pressure of oxygen is not effective in determining the formation of new tubers or leafy shoots. But with the partial pressure of this gas the roots fail to be provided with the usual hairs.—B. E. LIVINGSTON.

COPELAND²⁷ has studied the mechanism of the opening and closing movements of stomata in a large number of forms well distributed throughout the plant kingdom. Several methods were resorted to in determining the way in which the various stomata open and close, the main one being the observation of tangential sections of the leaf. Observations of cross and longitudinal sections and of the stomata *in situ* were also made use of. Unless the methods are at fault (and there seems no reason to believe that

²⁶ VÖCHTING, HERMANN: Ueber die Keimung der Kartoffelknollen. Bot. Zeit. 60: 87–114. *pls.* 3–4. 1902.

²⁷ Copeland, E. B., The mechanism of stomata. Annals of Botany 16: 327–364. *pl.* 13. 1902.

they are), it appears that active movements of stomata are much more common than we have been led to believe. And the method of opening and closing, apparently always dependent upon an osmotic change in volume of the guard cells, is as various as are the plants in which it occurs. Absorption of water with its accompanying increase in the volume of the guard cells results in so altering the shape of these cells, by bending or stretching their walls, as to open the pore between them. The mechanical types of stomata studied are illustrated by figures and are tabulated by the author in the following scheme, which is copied from his concluding paragraph. "The pore opens by

1. A change in shape, rather than by stretching the walls, in which the change is

- (a) An increase in the depth of the guard cell, in which there is chiefly concerned the entire wall except the dorsal (*Medeola*, *Equisetum*), the inner half (*Mnium*), the outer half (*Funaria*), the dorsal half (*Lycopodium*), the ends (*Osmunda*).

- (b) An increase in the width of the slender stoma (*Sagittaria*).

2. Stretching the thin dorsal wall (*Amaryllis*).

3. A change in shape, with or without much stretching, at the ends of the guard-cells, which forces the dorsal wall, with the passive middle part of the cell, either directly backward (*Gramineae*), or upward and backward (*Coniferae*).

4. Combinations of the types of *Amaryllis* and *Mnium* (*Helleborus*), and of *Amaryllis* and the *Gramineae* (*Achillea*)."—B. E. LIVINGSTON.

SPINDLE FORMATION in *Agave americana* has been described recently by Osterhout.²⁸ Considerable attention was given to technique, especially to fixing. About forty fixing agents were tested by watching their effect upon the living cell, and it was found that some of the most highly recommended solutions produced profound disturbances in the cytoplasm. For most objects fixing agents were found which produced no visible change in the living cell, as far as could be observed with a 2^{mm} oil immersion lens during the application of the reagent; but even in some such cases the material undergoes structural changes after a few hours, and the time must be shortened accordingly. Flemming's strong mixture proved to be the best in most cases; very fair results were obtained with iridium chloride, platinum chloride, palladium chloride, and Flemming's strong mixture with an excess of chromic. Material was washed from two to eight hours in running water and then dehydrated. Mixtures of absolute alcohol and bergamot oil were used for clearing. Gentian violet was used for staining kinoplasm. If the stain washes out too readily, some gentian violet should be dissolved in the absolute alcohol. From two to twenty seconds' immersion in dilute iodide iodine solution just before transferring to the absolute alcohol often gives a sharper differentiation.

²⁸OSTERHOUT, W. J. V., Cell Studies. I. Spindle formation in *Agave*. Proc. Cal. Acad. Sci. III. 2: 255-284. pls. 25-28. 1902.

The summary of Professor Osterhout's work on spindle formation in *Agave americana* is partly as follows: During early stages in the first division of the pollen mother cell the spindle is enclosed in a special membrane of cytoplasmic origin, which forms a complete investment around it. The functions of the membrane appear to be comparable to those of the nuclear wall and the limiting membrane of the cytoplasm. There is no weft of fibers such as is usually described for this stage. The spindle-forming fibers are radial from the beginning, and are attached both to the nuclear and spindle walls. The second division differs radically from the first, the spindle-formation resembling, in general, that described for the spore mother cells of *Equisetum*.

The plates are in three colors, reproducing the effect of the safranin-gentian violet-orange stain.—CHARLES J. CHAMBERLAIN.

A PHYSIOLOGICAL STUDY OF THE ANTIPODALS has been undertaken by T. Ikeda.²⁹ Investigations on *Tricyrtis hirta* form the subject of the first paper and it is expected that others will follow. Besides observations on microtome sections prepared in the usual way, microchemical reactions were tested on free-hand sections from fresh materials. The archesporial cell becomes the megaspore mother cell directly without a previous division into a primary wall cell and primary sporogenous cell; the mother cell gives rise to four megaspores, of which the one nearest the chalaza is functional. In the first division of the mother cell the chromatin forms tetrads strongly resembling those of such forms as *Gryllotalpa*, as described by zoologists. Double fertilization was observed. The endosperm does not form a parietal layer, but the nuclei are evenly distributed throughout the sac. A considerable amount of endosperm is formed before the division of the fertilized egg, one of the figures showing twenty nuclei in a single section. The chief interest in the paper lies in the microchemical investigation. In early stages no starch is found in the ovule, but as development proceeds starch appears in the funiculus and outer integument, and the outer and inner surfaces of the inner integument become cutinized except in the micropylar region. Starch then appears in the inner integument, though not as abundantly, and dextrin can be detected in the antipodal end of the sac. Just before the fusion of the polar nuclei, dextrin is evident in the micropylar portion of the inner integument and also in the antipodals and egg apparatus, while the starch has disappeared from the inner integument and appeared in the nucellus. After fertilization, the dextrin disappears from the integument and is present only in the fertilized egg, and starch has almost entirely disappeared from the integuments and is scanty in the funiculus, but after a few divisions of the embryo starch becomes abundant in the integuments and in the endo-

²⁹ Studies in the physiological functions of antipodals and related phenomena of fertilization in Liliaceae. Bull. Coll. Agric. Tokyo Imp. Univ. 5: 41-72. pls. 3-4. 1902.

sperm. The chalaza and conducting region have a soluble carbohydrate instead of starch. Microchemical tests, together with the cytological features of the antipodal cells and the anatomical structure of the neighboring tissues, lead to the conclusion that in *Tricyrtis* the antipodals are the center of absorption of raw materials, of their elaboration into the proper form, and the means of transmission of food to the proper place. The dextrin in the micropylar portion of the integument is believed to serve for the nutrition of the pollen tube, while that in the egg supplies the embryo during its early stages. The cutinization of the inner integument makes it necessary for most food material from the exterior to pass through the antipodals.—CHARLES J. CHAMBERLAIN.